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ABSTRACT

The results of a survey related to the impact of various recommendations on preservice content programs for teachers of mathematics are reported. The content of current programs is compared to the recommendations of the Committee on Undergraduate Programs in Mathematics (CUPM). The acceptance of CUPM and the Cambridge Conference on School Mathematics (CCSM) are reported. Information regarding organizations that were perceived to have directly influenced changes since 1960 was also obtained. (MP)

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# Influences on Mathematical Preparation of Secondary School Teachers of Mathematics

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## INTRODUCTION

Those who have lived through a period of revolution cannot but feel a certain nostalgia as the events which shaped an important part of their professional lives become part of a hazy mythology of bygone days. As ancient counter revolutionaries unfurl their once-trampled banners and raise new levies from many sources, one may wonder if there will be any lasting impact from those battles of yesteryear.

The answer to the wonderment must be a resounding "Yes"! One important result of and monument to the revolution is the set of requirements for mathematics content courses in the preservice education of teachers of secondary mathematics. Considering the inertia present in the curriculum change process in colleges and universities, these requirements will tend to remain in effect long beyond the active influence of those who effected their adoption.

It was obvious to the mathematics education community that in order to change the teaching of mathematics, the mathematics teachers must be changed. To this end the National Science Foundation sponsored summer, inservice, and academic year institutes for the retraining of teachers of mathematics. Various organizations suggested modifications in training of teachers of mathematics.



SE 026 960

It is the impact of these various recommendations on preservice content programs for teachers of mathematics, with which this article is concerned.

The Committee on Undergraduate Program in Mathematics (CUPM) of the Mathematical Association of America published a set of guidelines in 1961 for the training of teachers of mathematics (1), which were later revised and updated in 1971 (2). In 1963 the Cambridge Conference on School Mathematics (CCSM) suggested a more ambitious revolution in school mathematics which would have required major revisions of the preservice mathematics content program if the recommendations were to be adopted (4).

A recent report has suggested a set of mathematical competencies for teachers of secondary school mathematics which are not in conflict with the CUPM recommendations, but do reflect some changes in emphasis in mathematics education in recent years (5).

Another recent report suggests the following with regard to the content preparation of secondary school teachers of mathematics:

> The senior high school teacher's content preparation is little changed from the 1960's except that more recent graduates are more likely to have worked with computers, are more likely to have taken courses in probability and statistics and perhaps combinatorics, and may have been exposed to some serious work in applications or modeling. Given that more of them will teach geometry than any content other than algebra or general math, it is likely that the weakest link in their content preparation is geometry (3).

## A SURVEY OF CURRENT CONTENT PROGRAMS

A recently completed study surveyed the chairpersons of the departments of mathematics in 749 institutions of higher learning in the United States, with respect to the required mathematics program for secondary school teachers of mathematics. Four hundred forty-eight (60 percent) questionnaires were returned. Thirty of those questionnaires were not used, for reasons such as the following: (1) the institution prepared only elementary school teachers;

(2) the institution offered mathematics courses only to graduate students; and

(3) the questionnaire was inappropriate to their particular institution.

The writers examined the characteristics of the respondent institutions and determined that there were no systematic differences between them and nonrespondent institutions in terms of the following variables: geographic location, the highest degree offered by the mathematics department, and number of semester hours required for a mathematics major. The results reported below are based on the 418 usable returns (6).

One section of the questionnaire asked for the number of semester hours required for a major for teachers of junior high and senior high school mathematics. The mean number of semester hours of mathematics required by institutions of higher learning which offered a specific preservice junior high program was 31.42 semester hours, while 33.28 semester hours were required for a preservice high school mathematics teacher.

Another section of the questionnaire requested information concerning the number of content hours of mathematics required in various branches of mathematics. Other sections asked about changes in mathematics content programs since 1960 and about possible increases in mathematics requirements. The responses to these items are compared to the CUPM recommendations in Table 1.

Inspection of Table 1 indicates that the CUPM recommendations are largely being met in the areas of calculus, analysis, modern algebra, and linear algebra. With the exception of calculus, about one-fourth of the institutions indicated an increase in the requirements in each area since 1960. Only a very few institutions indicated they felt a need for increasing the requirements in these areas.

The data in Table 1 reveals that, on the average, the requirements fall short of the CUPM recommendations in the areas of probability and statistics,

TABLE 1

MATHEMATICS COURSES REQUIRED AND TRENDS OBSERVED IN 418 INSTITUTIONS OF HIGHER LEARNING IN THE UNITED STATES

| Subject Area | Mean No. of Semester Hours Required | No. of Institutions Indicating an Increase Since 1960 as an Important Change | No. of Institutions Indicating a Need to Increase as Important | CUPM Recommendations | |
|---|---|---|---|---|---|
| | | | | No. of Semester Hours | Met |
| Calculus | 10.83 | 2 | 0 | 9 | Yes |
| Analysis* | 2.95 | 80 | 5 | 3 | Yes |
| Modern Algebra | 2.72 | 105 | 10 | 3 | Yes |
| Linear Algebra | 2.05 | 111 | 1 | 3 | Yes |
| Probability & Statistics | 1.56 | 95 | 28 | 6 | No |
| Geometry | 2.45 | 117 | 38 | 6 | No |
| Computer Science | 0.67 | 108 | 50 | 3 | No |
| Applications | 0.05 | 6 | 47 | 3 | No |

*Analysis is defined here as those courses in introduction to analysis, differential equations, advanced calculus, real variables, complex variables, and numerical analysis.

geometry, and computer science, despite reported increases in the requirements since 1960 by about one-fourth of the institutions. About ten percent of the institutions indicated that they felt an increase in the requirements in these areas was needed.

The recommended requirement in applications is shown in Table 1 as the area in which there is the minimum requirement. About ten percent of the institutions felt that they should increase their requirements in this area.

In comparing the average requirements listed in Table 1 with the CUPM recommendations, it should be noted that the "average" program contained approximately twelve semester hours of electives in addition to the requirements tabulated. The respondents indicated that courses frequently taken, but not required, often fell into the very areas in which the average required program fell short. Thus it would seem that, for the most part, the content program required, or elected by most preservice mathematics majors is within a reasonable epsilon of that recommended by the CUPM.

Only nine percent of the respondent institutions indicated that they offered one or more mathematics courses designed for junior high school teachers of mathematics. This would seem to be a weakness in the scope of the offerings in most institutions.

## ACCEPTANCE OF CUPM AND CCSM CONTENT RECOMMENDATIONS

One section of the questionnaire asked respondents to indicate their knowledge and acceptance of the CUPM recommendations for content programs and of the recommendations of the Cambridge Conference on School Mathematics.

The information presented in Table 2 shows the responses to the following two questions which were part of the questionnaire:

(a) Do you endorse the Level II-J and Level III recommendations for undergraduate secondary teachers made by CUPM?
(b) Do you believe that the 1963 Cambridge Conference Goals for School Mathematics are realistic for secondary teachers?

TABLE 2

ACCEPTANCE OF THE CUPM RECOMMENDATIONS AND THE CAMBRIDGE CONFERENCE GOALS

| Responses | CUPM | | CCSM | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Yes | 291 | 69 | 69 | 17 |
| No | 49 | 12 | 196 | 47 |
| Not familiar with the recommendations | 66 | 16 | 147 | 35 |
| Did not complete | 12 | 3 | 6 | 1 |
| Total | 418 | 100 | 418 | 100 |

On the basis of the results shown in Table 2, it would seem that the CUPM recommendations are widely known and well accepted. The recommendations of the Cambridge Conference, however, are either unknown or are rejected by the chairpersons of most of the mathematics departments.

## AGENCIES SEEN AS INFLUENTIAL IN PROMOTING CURRICULUM CHANGE

Information regarding organizations that were perceived to have directly influenced changes since 1960 in the mathematics content program for preservice secondary school mathematics teachers, was obtained in another section of the questionnaire. The respondents were asked to rank the organizations that had influenced changes in their secondary preservice mathematics content programs since 1970. Most respondents indicated that more than one organization had been influential. Some respondents did not rank the organization but simply stated which organizations had been instrumental in effecting change. Table 3 presents a summary of the respondents which ranked the organizations that have contributed toward change in content programs. Columns other than the first do not total to one hundred percent, since the number of organizations perceived to have been influential varied with each respondent.

The data presented in Table 3 indicates that the CUPM was by far the most influential organization, as seen by the department chairpersons who ranked it most influential 52 percent of the time and failed to mention it only 17 percent of the time. While the National Council of Teachers of Mathematics was mentioned on just over half of the responses, it must be recalled that the NCTM did not promote a content program of its own, but rather supported those programs recommended by the CUPM. Organizations frequently associated with teacher education such as the college or department of education or the state department of education ranked well down on the list of influential organizations. The least frequent influence on the mathematics program was considered to be the Cambridge Conference.

TABLE 3

RANK OF ORGANIZATIONS WHICH HAVE DIRECTLY INFLUENCED CHANGES SINCE 1960 IN SECONDARY PRESERVICE MATHEMATICS CONTENT PROGRAMS IN 330 INSTITUTIONS OF HIGHER LEARNING IN THE UNITED STATES

| Organizations | Percent of Time Ranked | | | | | | | | Percent of Time Not Ranked |
|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 0 |
| State Department of Education | 10 | 9 | 9 | 9 | 3 | 1 | 1 | 0 | 58 |
| The College (or Department of Education In Your Institution | 4 | 8 | 9 | 3 | 5 | 3 | 1 | 0 | 67 |
| State Mathematics Organizations | 1 | 5 | 9 | 6 | 3 | 1 | 1 | 0 | 74 |
| Committee on Undergraduate Programs In Mathematics (CUPM) | 52 | 19 | 8 | 3 | 1 | 0 | 0 | 0 | 17 |
| The Cambridge Conference Goals for School Mathematics (CCSM) | 0 | 1 | 3 | 5 | 4 | 1 | 3 | 0 | 83 |
| National Council of Teachers of Mathematics | 1 | 23 | 11 | 9 | 4 | 3 | 0 | 0 | 49 |
| Your Institution's Curriculum Revision Committee | 18 | 14 | 8 | 4 | 1 | 1 | 0 | 0 | 54 |
| Others (such as Mathematics Department, Mathematics-Education Committee, Other Universities, Mathematics Advisory Panel, National Science Foundation, State Legislature, Mathematical Association of America) | 14 | 5 | 5 | 1 | 1 | 0 | 0 | 0 | 74 |

## IMPLICATIONS FOR FUTURE REVISIONS IN CONTENT PROGRAMS

There would seem to be an important lesson in the study reported above for those promoting changes in the preservice mathematics preparation of teachers. It is clear that the CUPM recommendations are widely known, accepted, and credited with being a significant influence in curriculum change in departments of mathematics. If the mathematics education community wishes to implement further changes, in whatever direction, in the mathematics component of the preservice preparation of teachers, the attempt should be made through and with an organization such as the Mathematical Association of America. This is due to the fact that this organization has high credibility with the departments of mathematics from which most proposed changes in content programs must originate.

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